US Army Corps of Engineers®

Ice Engineering

U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire

Ice Jams in Alaska

An ice jam is an accumulation of ice in rivers that restricts flow and can cause destructive floods costly to riverine communities. Freezeup jams occur in early to midwinter when ice first forms in rivers. Breakup jams form in early spring when rising air temperature and/or rain events lead to rapid snowmelt, increases in runoff, and rapid increases in flow discharge. Ice covers break up and the resulting ice floes can become lodged at river bends, bridges, or narrow sections on the river, or, more often, stop and accumulate where the river slope suddenly changes from relatively steep to mild. The ensuing blockage of the river cross section can cause a rapid rise in water levels that often leaves little time to prepare for flooding.

Besides upstream flooding, ice jams often create serious problems to navigation. Damages to areas downstream of the ice jam can also be severe when the jam releases. The resulting water and ice surge can lead to the loss of barges and towboats, damages to mooring areas, bed and bank erosion, damage to wildlife and its habitat (Fig. 1), and failure of bridges and other riverine structures. Flooding and structural damage caused by ice jams to roads, bridges, buildings, and homes result in severe financial cost to the affected towns. Engineers at the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) have been developing structural and nonstructural techniques to prevent and alleviate the damages caused by ice jams, such as ice dusting, ice breaking and removal, and ice control structures (Corps of Engineers 1994). Methods of predicting ice jam occurrence and severity are also being developed.

The latter efforts, partly based on statistics and probability analysis, require the compilation of accurate and reliable data on past ice jam events. The CRREL Ice Jam Database is such a compilation of freezeup and breakup ice jam events in the United States (White 1996). Currently there are over 10,000 records in the database, with the earliest account dating from 1780. For each ice jam event the information in the database includes the river name, city, state, year, month, jam date, jam type, damages, a short description, a listing of publications, latitude and longitude, US Geological Survey hydrologic unit code, and USGS gage number, if available.

Figure 1. This moose was trapped on an ice floe on an Alaskan river during spring breakup.

The Alaska Ice Jam Database

This *Ice Engineering Information Exchange Bulletin* provides a brief summary of ice jam data for Alaskan rivers that is contained in the CRREL Ice Jam Database. The largest state of the Union, Alaska is located in the subarctic and arctic regions of the globe, and ice jams occur frequently on its 3,000 rivers (Herb 1993). However, because of its relatively small population of 587,800 people (as of the 1992 census), ice jam floods may cover large areas without endangering any people or towns. On the other hand, many Alaskans depend on rivers as a source of food and transportation (Fountain 1984), and as a result many towns are situated on river banks, thus placed at risk for ice jam flooding. As of December 1996, there were 747 Alaskan ice jam events documented in the CRREL Ice Jam Database. A substantial amount of the information on ice jams in Alaska was collected from the files of the National Weather Service in Anchorage, Alaska, and as a result 74% of the source publications are from the NWS. A series of CRREL Special Reports on ice observations in the North American arctic and subarctic (Bates and Bilello 1960–1974) provided about 4% of the ice jam information. The Alaska Divi-

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Abstract

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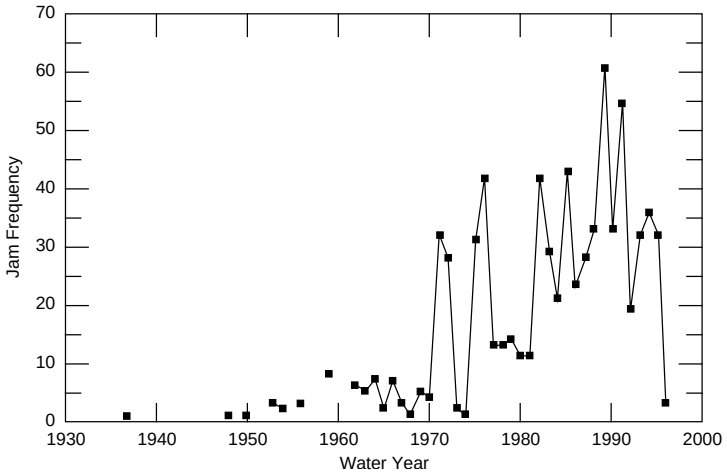

Figure 2. Ice events reported in Alaska, 1930 through 1996.

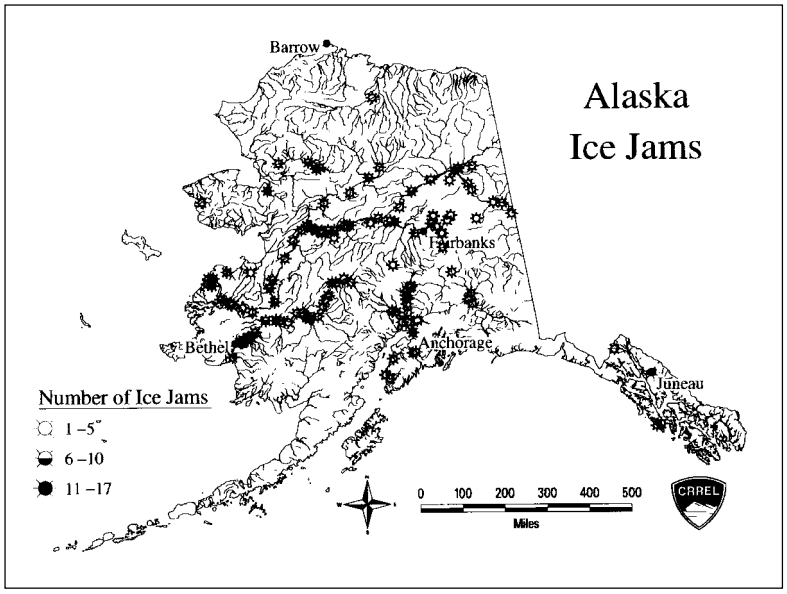

Figure 3. Location of ice jams in Alaska reported in the CRREL Ice Jam Database.

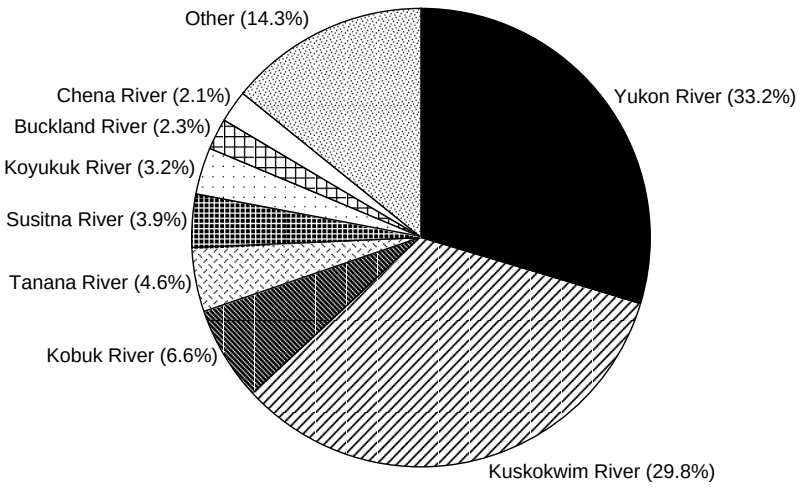

Figure 4. Percentage of Alaskan ice jam entries that occur on specific rivers.

sion of Emergency Services (ADES) was the source of about 5% of the information. The remaining sources of information (17%) are the USGS, the Alaska District of the Corps of Engineers, CRREL, and newspapers. The earliest entry in the Ice Jam Database for Alaska is a 1937 event in Fairbanks. For the years from 1937 to 1970, only 56 ice jams in Alaska are recorded in the database (Fig. 2). The lack of ice jam data before 1970 is partly due to the fact that a network of USGS gaging stations was not established until the late 1940s and early 1950s (Lamke 1989). In addition, although Alaska was purchased in 1867, it was not admitted to the Union until 3 January 1959, which may have hampered systematic record keeping (Herb 1993).

Where do ice jams in Alaska occur?

The database contains information on ice jam events at 149 different locations (four locations are unknown) on sixty different rivers in Alaska, as shown in Figure 3. About 86% of the known ice jams occurred on eight rivers: the Yukon, Kuskokwim, Kobuk, Tanana, Susitna, Koyukuk, Buckland, and Chena Rivers (Fig. 4). The Alaskan river with the most ice jams recorded is the Yukon River, with 248 events (Fig. 5), followed by the Kuskokwim River with 222 events (Fig. 6); these are the

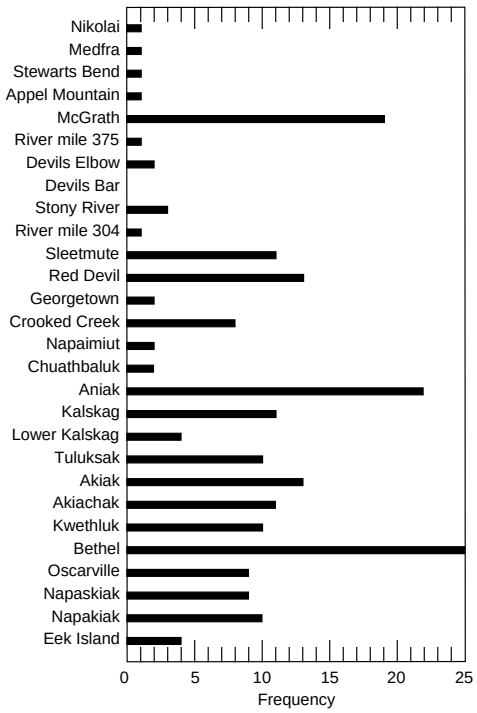

Figure 5. Frequency and location of ice jams on the Kuskokwim River.

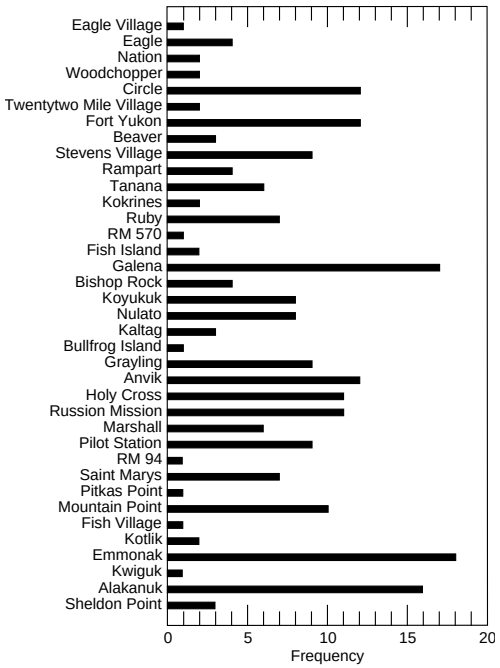

Figure 6. Frequency and location of ice jams on the Yukon River.

two longest rivers in Alaska. The town of Bethel on the Kuskokwim River has the greatest number of recorded ice jams, with 26 events noted (Fig. 6).

It is important to note that the high number of recorded ice jam events on the Kuskokwim and Yukon Rivers is affected by the availability of information. The existence of ice jam data depends on who is affected and whether the information is reported. Jams that occur away from populated areas are not likely to be recorded. There could well be a river that experiences more jams than the Yukon River, but because there are few people living near the river, few if any floods or ice jams are ever reported. Perception stage is particularly important in a sparsely settled state like Alaska. Perception stage can be defined as the stage at which a problem (e.g., ice-jam-induced flooding) is perceived. Perception stage can vary; USGS gages might have a precise perception stage at which water goes overbank, while local residents may perceive only those ice jams that directly affect them. Sometimes perception stage can be quite high; when contacted by telephone about ice jam flooding at Akiak in 1983, Hugh Olsen reported: "It's not really a problem, [but] I'm standing in about four inches talking to you (Campbell 1983)."

When do ice jams in Alaska occur?

The number of ice jam reports varies greatly from year to year (Fig. 2), with the highest number of ice jams (61) recorded in 1989. The number of ice jams reported in the database in certain years largely depends on the jam location and availability of jam records. For example, in 1991, one of the more populated areas, Fairbanks, experienced extensive ice jam flooding. As a result, news stories and other publications emphasized ice jam occurrences everywhere in Alaska more than usual that year, and 55 ice jams are recorded in the database for 1991.

Ice jam occurrence also depends on the time of year. Of the 747 ice jam events in the database for Alaska, 663 occurred in May, when the rivers begin to break up (Fig. 7), indicating that Alaskan ice jams are largely breakup ice events.

Who is affected by ice jams in Alaska?

In this cold, sparsely populated state, many people depend on rivers to provide food and transportation. For many Alaskans, the breakup of river ice means the end of frozen highways and the start of open water transportation (Fountain 1984). Most people who live along rivers expect flooding during the time of breakup, and simply move to higher ground (Hunt 1991). For example, in Emmonak (located on the Yukon River), flooding is a way of life. All homes are on pilings and during high water the power plant is shut down and people visit each other in skiffs (Hunt 1991). Said the City Manager, "Nobody really gets excited. Everything is put away and everything raised up, and we deal with it (Hunt 1991)." However, ice jams can take towns by surprise, with rapid flooding and extensive damage caused by ice floes that are carried out of the river banks.

Of the 149 different locations noted in the database, only nine have a population greater than 1,000 (1995 census data). The most populated area to be affected by an ice jam is Anchorage, which had a 1995 population of 257,780. Eighty-two of the towns in the database had fewer than 1,000 people in 1995. Fifty-four of the locations in the database were described as not populated in the 1995 census.

People are not the only ones affected by ice jams. In 1989, an ice jam on the Nowitna River created a lake hundreds of square miles in area, and high-water marks forty miles upstream were nine feet above the riverbank (Hunt 1991). A flyover of the flooded area found nine moose trapped on a small knoll (Hunt 1991) (Fig. 1). Loss of fish, wildlife, and riverine habitat and its effect on local economies has not yet been documented.

Ice jam damages in Alaska

Like the database as a whole, many of the sources relied upon for information on ice jams in Alaska lack quantitative data on damages. Only recently have damages been reported by the ADES Preliminary Damage Assessment Team. Of the 747 Alaskan ice jam events in the database, 146 (19.5%) have known damages, a much higher percentage than the whole database (about 2%). The most common damages reported include lowland flooding, bank erosion, flooded homes, and road damage. A typical report might be the 1989 ice jam flood in Alakanuk on the Yukon River, in which ice took two homes off of their pilings (Hunt 1991). Some ice jam floods can cause extensive damage and be quite costly for communities.

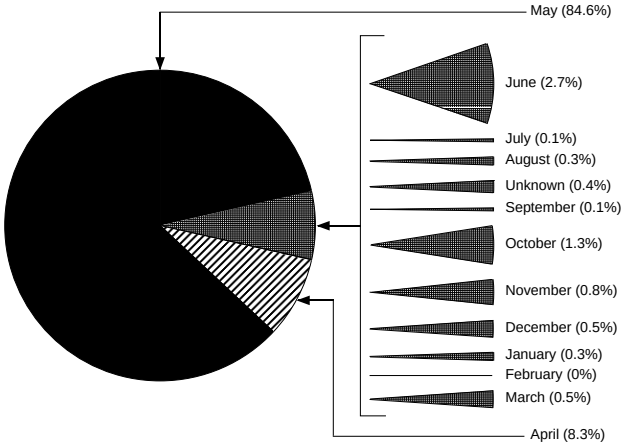

Figure 7. Months for which ice events are reported in Alaska.

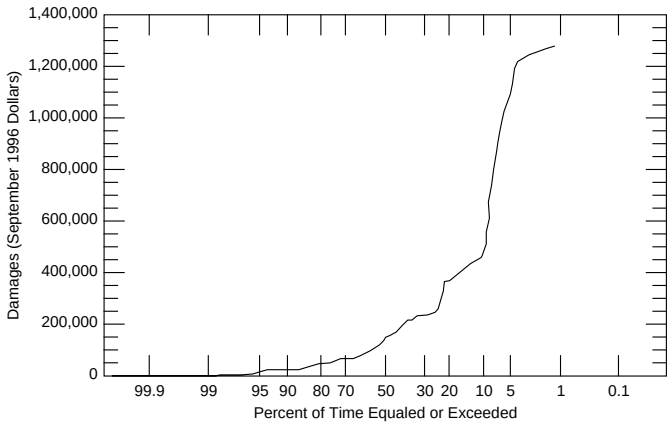

Figure 8. Reported ice jam flood damages in Alaska, 1982–1994, calculated in September 1996 dollars.

In 1971, ice jam damage in the towns of Akiak and Napakiak on the Kuskokwim River, and the towns of Galena and Sheldon's Point on the Yukon River totaled about $6.96 million in September 1996 dollars. More recently, in 1994, an ice jam on the Yukon River in the town of Galena cost $380,000 in damages (September 1996 dollars). Figure 8 presents the exceedence probability calculated for jams with reported damages between 1982 and 1996.

How is this information helpful?

The Ice Jam Database provides quick access to general information about specific ice jam events, an important feature for those interested in the ice jam flooding history of a certain area. These historical data are crucial during emergency situations where information about jam locations or stages would be helpful. Historical information is also important for studies at specific sites. For example, CRREL is currently assisting the Alaska District, Corps of Engineers, on the Kuskokwim River Navigation Reconnaissance Study. The use of historical ice jamming data will help determine the feasibility of navigation on the lower Kuskokwim River. Hydrological data are also used to make predictions about ice jam occurrences. In an article in *The Northern Engineer*, Andrew G. Fountain (1984) noted that much remains to be done in the effort of predicting ice jam floods and that an examination of river ice breakup statistics would aid in the process. In addition, the Cold Regions Center for Expertise (CRCX) was created on 13 June 1996 in an effort to join the expertise of the U.S. Army Cold Regions Research and Engineering Laboratory and the Alaska District of the Corps of Engineers. The establishment of the CRCX increases the opportunity for future projects that will depend on the Ice Jam Database for historical data.

CRREL also has an Ice Jam Archive that contains the hard copies of the NWS reports, newspaper articles, and other reports used as sources for ice jam data for Alaska and other states in the database. The information can be checked out or photocopied for research.

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Please send any information for inclusion into the Ice Jam Database and Ice Jam Archive to Lourie Herrin, Ice Engineering Research Division, CRREL, 72 Lyme Road, Hanover, New Hampshire 03755-1290. Photocopies of originals can be made and returned.

The CRREL Ice Jam Database may be downloaded via anonymous FTP on the Internet; it is located on the "icejam" directory of 144.3.2.11 (bbsun.usace .army.mil). It is also available via the CRREL Home Page (http: / / www .usace.army.mil / crrel / icejam /).

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This edition of Ice Engineering *was written by Heidi J. Eames, Engineer Aid, and Kate White, Research Hydraulic Engineer, of the Ice Engineering Research Division (IERD) of the U.S. Army Cold Regions Research and Engineering Laboratory, and was edited by Gioia Cattabriga and laid out by John Severance of CRREL's Library and Technical Publishing Branch. Ms. Eames, a student at the University of Vermont, has worked on the CRREL Ice Jam Database for three years, concentrating on ice jams in Alaska for the past two years.*

Ice Engineering Information Exchange Bulletin

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